PATENT

CLAIMS

What is claimed is:

5   1.   A method for classifying sleep states, comprising:

detecting conditions related to sleep, the sleep-related conditions comprising a

condition associated with a sleep-wake status of a patient and a condition associated

with REM sleep; and

classifying one or more sleep states based on the detected conditions,

10   wherein classifying the one or more sleep states is performed at least in part

implantably.

2.   The method of claim 1, wherein both detecting and classifying are performed

at least in part implantably.

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3.   The method of claim 1, wherein detecting the condition associated with the

sleep-wake status of the patient comprises detecting patient activity.

4.   The method of claim 3, wherein detecting patient activity comprises detecting

20   patient activity using an accelerometer.

5.   The method of claim 3, wherein detecting patient activity comprises detecting

patient activity using a respiration sensor.

25   6.   The method of claim 1, wherein detecting the at least one condition associated

with REM-sleep comprises sensing a muscle tone.

7.   The method of claim 6, wherein sensing the muscle tone comprises sensing

the muscle tone using an electromyogram sensor.

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8.   The method of claim 6, wherein sensing the muscle tone comprises sensing the muscle tone using a strain gauge sensor.

9.   The method of claim 6, wherein the sensing the muscle tone comprises
5   sensing the muscle tone using a mechanical force sensor.

10.   The method of claim 1, wherein detecting the conditions related to sleep comprises detecting body posture.

10   11.   The method of claim 1, wherein detecting the conditions related to sleep comprises detecting torso orientation.

12.   The method of claim 1, wherein classifying the one or more sleep states comprises detecting the patient is asleep.

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13.   The method of claim 1, wherein classifying the one or more sleep states comprises detecting the patient is awake.

14.   The method of claim 1, wherein classifying the one or more sleep states
20   comprises classifying non-REM sleep.

15.   The method of claim 1, wherein classifying the one or more sleep states comprises classifying REM sleep.

25   16.   The method of claim 1, wherein classifying the one or more sleep states comprises classifying the one or more sleep states in a batch mode.

17.   The method of claim 1, wherein classifying the one or more sleep states comprises classifying the one or more sleep states on a real-time basis.

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18.   The method of claim 1, further comprising providing sleep state informed therapy using the sleep state classification.

19.   The method of claim 18, wherein providing the sleep state informed therapy
5   comprises providing respiratory therapy.

20.   The method of claim 18, wherein providing the sleep state informed therapy comprises providing cardiac therapy.

10   21.   The method of claim 18, wherein providing the sleep state informed therapy comprises providing preventive therapy.

22.   The method of claim 1, further comprising using the sleep state classification to perform sleep state informed diagnostic testing.
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23.   The method of claim 1, further comprising using the sleep state classification to perform sleep state informed testing of therapy parameters.

24.   The method of claim 1, further comprising using the sleep state classification
20   to perform sleep state informed monitoring of patient conditions.

25.   The method of claim 1, further comprising using the sleep state classification to determine physiological responses of the patient during sleep.

25   26.   The method of claim 25, wherein determining the physiological responses comprises determining intrinsic responses.

27.   The method of claim 25, wherein determining the physiological responses comprises determining evoked responses.
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28.   The method of claim 1, wherein classifying the one or more sleep states comprises adaptively classifying the one or more sleep states.

29.   The method of claim 28, wherein adaptively classifying the one or more sleep

5   states comprises:

learning sleep-related responses of a patient; and

classifying the one or more sleep states using the learned sleep-related

responses.

10   30.   The method of claim 29, wherein learning the sleep-related responses comprises:

detecting changes in the sleep-related signals over a period of time; and

learning the sleep-related responses based on the detected changes.

15   31.   A method for classifying sleep states, comprising:

sensing a physiological condition associated with REM sleep; and

classifying one or more sleep states based on the physiological signal,

wherein classifying the one or more sleep states is performed at least in part

implantably.

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32.   The method of claim 31, wherein both sensing and classifying are performed at least in part implantably.

33.   The method of claim 31, wherein classifying the one or more sleep states

25   comprises classifying REM sleep.

34.   The method of claim 31, wherein sensing the physiological condition associated with REM sleep comprises sensing skeletal muscle tone.

35.   The method of claim 34, wherein sensing skeletal muscle tone comprises sensing skeletal muscle tone using an electromyogram sensor.

36.   The method of claim 34, wherein sensing skeletal muscle tone comprises sensing skeletal muscle tone using a strain gauge sensor.

37.   The method of claim 31, wherein sensing skeletal muscle tone comprises sensing skeletal muscle tone using a mechanical force sensor.

38.   The method of claim 31, wherein classifying the one or more sleep states comprises classifying the one or more sleep states in a batch mode.

39.   The method of claim 31, wherein classifying the one or more sleep states comprises classifying the one or more sleep states on a real-time basis.

40.   The method of claim 31, further comprising providing sleep state informed therapy using the sleep state classification.

41.   The method of claim 31, further comprising performing sleep state informed testing using the sleep state classification.

42.   The method of claim 31, further comprising performing sleep state informed patient monitoring using the sleep state classification.

43.   The method of claim 31, further comprising using the sleep state classification in determining physiological responses of the patient.

44.   The method of claim 43, wherein determining the physiological responses comprises determining intrinsic responses.

45.   The method of claim 43, wherein determining the physiological responses comprises determining evoked responses.

46.   The method of claim 31, wherein classifying the sleep states comprises
5   adaptively classifying the sleep states.

47.   The method of claim 46, wherein adaptively classifying the sleep states comprises:
       learning sleep-related responses of a patient; and
10   classifying the one or more sleep states using the learned sleep-related responses.

48.   A medical system, comprising:
       a detector system, the detector system comprising a sensor configured to
15   detect a condition associated with REM sleep; and
       a classification system coupled to the detector system and configured to classify one or more sleep states based on the one or more sleep-related conditions, wherein the classification system includes an implantable component.

20   49.   The system of claim 48, wherein both the detector system and the classification system include implantable components.

50.   The system of claim 48, wherein the detector system further comprises a sensor configured to detect a condition associated with a sleep-wake status of the
25   patient.

51.   The system of claim 50, wherein the sensor configured to detect the condition associated with the sleep-wake status comprises a patient activity sensor.

52.   The system of claim 51, wherein the patient activity sensor comprises an accelerometer.

53.   The system of claim 51, wherein the patient activity sensor comprises a
5   transthoracic impedance sensor.

54.   The system of claim 48, wherein the sensor configured to sense the condition associated with REM sleep comprises a muscle tone sensor.

10   55.   The system of claim 54, wherein the muscle tone sensor is an electromyogram sensor.

56.   The system of claim 54, wherein the muscle tone sensor is a mechanical strain gauge.

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57.   The system of claim 54, wherein the muscle tone sensor is a force sensor.

58.   The system of claim 54, wherein:
        the muscle tone sensor is mechanically coupled to an implantable device; and
20   the classification system is disposed within a housing of the implantable
device.

59.   The system of claim 54, wherein the muscle tone sensor is mechanically coupled to a header of an implantable cardiac device.

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60.   The system of claim 54, wherein the muscle tone sensor is mechanically coupled to a housing of an implantable cardiac device.

61.   The system of claim 54, wherein the muscle tone sensor is mechanically
30   coupled to a lead system of an implantable cardiac device.

62.   The system of claim 48, wherein the classification system is configured to classify REM sleep.

5   63.   The system of claim 48, wherein the classification system is configured to classify non-REM sleep.

64.   The system of claim 48, wherein the classification system is configured to determine if the patient is asleep.

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65.   The system of claim 48, wherein the classification system is configured to determine if the patient is awake.

66.   The system of claim 48, further comprising a therapy system coupled to the

15   classification system and configured to provide therapy based on sleep state classification.

67.   The system of claim 66, wherein the therapy system is configured to provide cardiac therapy.

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68.   The system of claim 66, wherein the therapy system is configured to provide respiratory therapy.

69.   The system of claim 48, further comprising a testing system coupled to the

25   classification system.

70.   The system of claim 69, wherein the testing system is configured to test therapy parameters.

71.   The system of claim 69, wherein the testing system is configured to perform diagnostic testing.

72.   The system of claim 48, further comprising a monitoring system coupled to the

5   classification system and configured to collect data related to the one or more sleep states.

73.   The system of claim 48, wherein the classification system is configured to adaptively classify the one or more sleep states.

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74.   The system of claim 48, wherein the classification system is configured to learn sleep-related responses of a patient and classify the one or more sleep states using the learned sleep-related responses.

15   75.   A medical system, comprising:

    means for detecting conditions related to sleep, the sleep-related conditions comprising at least one condition associated with a sleep-wake status of a patient and at least one condition associated with REM sleep; and

    means for classifying one or more sleep states based on the detected

20   conditions, wherein the means for classifying is performed at least in part implantably.

76.   The system of claim 75, further comprising means for providing sleep state informed therapy using the sleep state classification.

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77.   The system of claim 75, further comprising means for using the sleep state classification to perform sleep state informed diagnostic testing.

78.   The system of claim 75, further comprising means for using the sleep state

30   classification to perform sleep state informed testing of therapy parameters.

79.   The system of claim 75, further comprising means for using the sleep state classification to perform sleep state informed collection of data.

5   80.   The system of claim 75, further comprising means for using the sleep state classification to determine physiological responses of the patient during sleep.

81.   A system for classifying sleep states, comprising:

means for detecting a condition associated with REM sleep; and

10   means for classifying one or more sleep states based on the condition associated with REM sleep, wherein the means for classifying is performed at least in part implantably.

82.   The system of claim 81, further comprising means for providing sleep state

15   informed therapy using the sleep state classification.

83.   The system of claim 81, further comprising means for performing sleep state informed testing using the sleep state classification.

20   84.   The system of claim 81, further comprising means for performing sleep state informed patient monitoring using the sleep state classification.

85.   The system of claim 81, further comprising means for using the sleep state classification in determining physiological responses of the patient.

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